DEPARTMENT OF AGRICULTURE, BENGAL.

ANNUAL REPORT

OF THE

DACCA AGRICULTURAL STATION

FOR THE YEAR 1911-12.

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THE BENGAL SECRETARIAT BOOK DEPOT.
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ANNUAL REPORT OF THE DACCA FARM FOR THE YEAR ENDING 30TH JUNE 1912.

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ANNUAL REPORT OF THE DACCA FARM FOR THE YEAR ENDING 30TH JUNE 1912.

Introduction.—This station is situated at Manipur, five miles out of Dacca. Area is 350·7 acres, of which 286·6 acres are high land, the remainder being low land. The land is representative of the laterite area, of which there is a fairly large area in the Province. No arrangements have been made for irrigation as yet and although the rainfall is fairly heavy and the water level in the rainy season comes to near the surface of the soil, from November to March, the land becomes as hard as a brick and is unsuitable for the growth of crops. The soil is suited to *aus* and *aman* paddy, but it has yet to be proved that sugar-cane can be grown economically while the returns from other crops have so far been heart-breaking, considering the amount of time, trouble and money spent upon them. A heavy Turnwrest Plough that costs Rs. 30 and that requires four big bullocks to pull, is turning up this soil very well, but whether such a practice can be followed by the cultivators of similar land who are the poorest in the Province, is very questionable. Such cultivators, to begin with, do not possess strong enough bullocks nor will they afford to feed sufficient concentrated food that is necessary to enable the bullocks to pull this heavy plough. This station of a necessity requires more upkeep than the others, on account of the head-quarters and experiments of the Chemist, Fibre Expert and Botanist being here. Most of the experimental work of these experts is carried out on this farm and this is one of the reasons for the heavy expenditure incurred.

Still we have something definite to recommend from this farm, viz :— "Bonemeal as a manure for Paddy". Also this station serves as a distribution centre for seeds, manures and implements for Eastern Bengal. The farm is also the chief training centre for apprentices, and although as yet we have not had very eligible young men we hope in the future to attract a better class. Apprentices in addition to being taught a business are provided with Rs. 15 per month *plus* free quarters. The training period is two years and the young men ought to have had sufficient

education to enable them to eventually arrive to the post of a Farm Superintendent otherwise the prospects of such apprentices are very poor indeed.

2. *Situation and brief history.*—This station is situated in 23°7, North Latitude and 90°4, East Longitude at Manipur five miles from Dacca, and is representative of a large tract of country in the Dacca district known as the Madhupur Jungle. The area is laterite, which is remarkable for the rapidity with which water drains away. The land was acquired in 1906, when most of the high land was under jungle and thatching grass. To begin with, the farm had to be laid out, roads built, buildings erected and the land brought into a fairly uniform condition before experimental work could be commenced.

This work is only now nearing completion, while the soil is so barren that crops other than *aus* and *aman* paddy for the first few years refused to grow satisfactorily. Continued ploughing in of green manure (*dhaincha*) with applications of lime has improved the soil to some extent, and we hope to grow now such crops as jute and sugarcane economically.

Many trees have had to be felled and removed to enable us to obtain compact areas large enough for experimental work.

The superior staff of the Department have their head-quarters and laboratories on this farm.

3. *Area.*—The area of the farm is 353·7 acres and of this 286 acres are high land while 69 acres are low land. Most of this high land in 1906 was under jungle, but yearly reclamation work has been undertaken until at present we have 141 acres of this land under cultivation, while 123 acres are taken up by buildings, roads, tanks, botanical area and paddocks so that practically speaking the whole farm is now under cultivation. During the year three acres more high land were brought under cultivation. This high land so far has only been able to grow *aus* paddy economically. The 69 acres of low land are all under cultivation. Good crops of *aman* paddy can be grown on this land.

4. *Irrigation.*—There is no artificial irrigation on this farm. The normal rainfall of the district is about 80 inches and this is spread well over the period from March to October so that the ordinary crops of *aus* and *aman* paddy as grown by the cultivators of this class of land are assured. The high land of this farm however cakes as hard as a brick in December and it is very questionable if *rabi*

crops can be grown on this area economically, while if irrigation be arranged it is very doubtful if the cost of irrigation would be recovered.

The low lands remain moist till December and yield heavy crops of *aman* paddy.

5. *Character of the soil.*—As stated above there are two types of land on this farm, and each type of land has its distinctive soil. The soil of the low land is very fertile, while that of the high land is very poor and where it has not been treated, even barren.

Both soils are highly ferruginous clay loams derived from laterite. Soils of the low land have been enriched by washings from the high lands.

I have not been able to obtain detailed analysis of soil and subsoil of each class of land on this farm for this report, but the following partial analyses of soil and sub-soil of the high land of the farm by Mr. Meggitt, the Agricultural Chemist, shows us how poor the soil is in phosphoric acid and lime, while when one remembers that the land contains a large percentage of iron one would conclude that the land is too poor in lime and phosphoric acid to be able to grow luxuriant crops:—

	Soil.	Sub-soil.
Organic matter	4·66	4·38
Combined water		
Nitrogen	0·134	0·093
Soluble in hydrochloric acid—		
Phosphoric acid (P_2 05) ...	0·04	0·04
Potash (K_2 0) ...	0·30	0·49
Lime (Ca 0) ...	0·18	0·10
Magnesia (Mg 0) ...	0 38	0·33
Soluble in 1 per cent. citric acid—		
Phosphoric acid (P_2 05) ...	0·003	0·002
Potash (K_2 0) ...	0·013	0·008
Calcium carbonate	0·047	0·024
Reaction of soil	acid	acid

Mr. Meggitt says:—"The soil is not deficient in nitrogen but is poor in phosphoric acid and lime and contains sufficient potash for all ordinary purposes. As the soil is acid all acid manures should be avoided. The sub-soil contains ferrous salts."

I hope, another year to give a more detailed analysis. I should like to know how much silica, alumina, iron and organic matter are contained in both the soil and sub-soil of the high land and low land of this farm, for the soils of this farm are absolutely different from those of Mymensingh where the best jute in the province is grown.

6. *Meteorology.*—The following table gives the actual rainfall and number of rainy days on the Dacca farm with the normal rainfall of the Dacca district.

Rainfall, Dacca Farm.

	Actual.	Number of rainy days.	Normal.	Number of rainy days.
April 1911	4·78	6	4·88	6·7
May „	21·67	20	9·60	11·3
June „	*23·56*	*19*	13·38	15·2
July „	11·83	14	12·85	17·4
August „	15·61	21	12·55	17·4
September „	4·92	9	9·43	11·7
October „	5·00	7	4·34	5·8
November „	0·68	4	0·81	1·1
December „	...	...	0·15	0·4
January 1912	22	1	0·38	0·9
February „	·03	1	1·12	1·8
March „	2·48	5	2·59	3·5

From the figures it will be seen that the actual rainfall of 1911-12 was well above the normal. Now the rainfall of April, May and June 1912 have no connection whatsoever with the crops under discussion in this report, so we have had to add the figures for April, May and June 1911. These figures show that the recorded rainfall was well above the normal and that there was plenty of natural rainfall for growing all crops between April and October inclusive.

The year 1911 meteorologically was favourable to jute, *aus* paddy, *aman* paddy and sugarcane on the Dacca farm. If the soil were not laterite the natural rainfall would be sufficient to grow good *rabi* crops, but owing to the want of the waterholding capacity and of the retentive power of these soils the high land becomes quite burnt up and like a brick in December.

This is fatal to *rabi* crops.

7. *Operations during the year.*—(*A*) General crops grown.—The following table gives the area of each crop grown on the farm during 1911-12 with the total outturn and yield per acre :—

Crop.	Area sown.	Total outturn.	Yield per acre.	Remarks.
	Acres.	Mds.	Mds.	
Winter paddy ...	60	1,470¾	24½	Good.
Aus paddy ...	63	1,209	19⅕	Do.
Til	32⅓	90¾	2¾	Bad.
Matikalai ...	34⅔	78	2½	Bad.
Mung ...	23⅔	5¼	...	??
Rahar ...	13	55¾	4	Bad.
Dhaincha ...	3⅔	11¾	3	Do.
Oats ...	5⅔	17	3	Do.
Mustard ...	7	26½	3⅔	Do.
Sugarcane ...	1 acre Ratooned.	21	21	...
	5⅓	150⅔	30 plus canes.	Very poor.
Jute ...	5	35¾	7	Bad.

From these figures it is evident that only *aus* and *aman* paddy grew properly and these were only fair.

(B) *Experimental area.*—This area is divided into—

(1) Botanical area under Mr. Hector, Economic Botanist.

(2) Area devoted to fibre plants under Mr. Finlow, Fibre Expert.

(3) High Land Experiments.

(4) Low Land Experiments.

Numbers 1 and 2 are under Messrs. Hector and Finlow, respectively, who will deal personally with these areas in their annual reports. Mr. Meggitt is making detailed studies of 3 and 4 and the appendix at the end of this report gives his conclusions up to date.

(3) High land experiments :—

A. Improvement of the high land :—

(*a*) Effect of green manure.

(*b*) Effect of green manure, phosphoric acid and lime.

(*a*) *Effect of green manure.*—This experiment was commenced in 1908, the main object being to test the effect of green manure in the improvement of this class of soil. There are 4 plots each $1\frac{1}{3}$ acre in extent and the idea has been to compare 2 plots of a *rabi* crop after green manure and 2 plots after *aus* paddy. In the former case of course, we lose the *aus* paddy crop which is so valuable to the poor raiyat of the Madhupur Jungle tract. This experiment was carried out in the years 1908, 1909 and 1910, when it was found that the yields of *rabi* crops were too poor to be of any economic value so it was decided to apply more manure and lime to see if that would give a satisfactory utturn from the *rabi* crops.

The following table shows the treatment of the 4 plots in 1911-12 with the outturn of *aus* paddy and crop *rabi* (oats) from each plot:—

Plot number.		Manure and *Kharif* season crop.	Outturn.		Outturn per acre.	
			Kharif (Aus).		*Rabi* (Oats).	
			Grain.	Straw.	Grain.	Straw.
A.	N. Half	30 Mds. lime, *aus*. 100 Mds. cowdung.	$26\frac{7}{8}$	$25\frac{5}{8}$	$4\frac{3}{4}$	$10\frac{3}{4}$
	S. „	100 Mds. cowdung,	$27\frac{1}{8}$	23	$2\frac{7}{8}$	$6\frac{5}{8}$
B.	N. „	Sunn g. m. ...	...	...	3	$4\frac{5}{8}$
	S. „	Sunn g. m. + 30 Mds. lime	...	...	$3\frac{3}{4}$	$7\frac{1}{4}$
C.	N. „	30 Mds. lime, + *dhaincha* green manure.	...	...	$3\frac{1}{4}$	$6\frac{3}{4}$
	S. „	*dhaincha* g. m. ...	...	...	$2\frac{1}{4}$	$5\frac{1}{8}$
D.	N. „	300 Mds. leaf-mould, *aus*.	23	$19\frac{1}{3}$	$1\frac{1}{4}$	3
	S. „	300 Mds. leaf-mould, —. 30 Mds. lime, *aus*	$25\frac{5}{8}$	$28\frac{3}{4}$	$3\frac{1}{4}$	$6\frac{1}{4}$

From the above figures it is pretty evident that the outturns of the *rabi* crop are very bad, and that it will never do to lose the valuable *aus* paddy crop for the purpose of green manuring the land for a doubtful *rabi* crop.

I am inclined to think that such high land without irrigation will never grow a good *rabi* crop.

(*b*) Effect of green manure, phosphoric acid and lime on high land.

This experiment was commenced in 1911 and is based on the results of experiment (*a*) above.

The attached plan gives full details of the experiment with the actual outturns per $\frac{1}{16}$ acre in 1911-12.

The main point is that half the area grows aus paddy in addition to a *rabi* crop, while half only grows a *rabi* crop after *dhaincha* green manure. In the one case therefore we lose the *aus* paddy crop. To further check the results duplicate plots in each case have been taken.

The following tables show the outturns per acre :—

Plots.	Numbers.	Manures.	Mds.		Aus Paddy. (Grain yield per acre in maunds.) Mds.	Duplicate. Mds.
1	(*a*)	Cowdung	100	...	$18\frac{7}{8}$	$22\frac{3}{4}$
	(*b*)	Cowdung Lime	100 10	...	$16\frac{5}{8}$	$23\frac{3}{4}$
	(*c*)	Cowdung Lime	100 30	...	17	24
	(*d*)	Cowdung Lime	100 60	...	41	$24\frac{1}{8}$
2	(*a*)	Bonemeal to *aus* Cowdung to mustard	3 100	...	$21\frac{1}{4}$	$29\frac{1}{8}$
	(*b*)	Bonemeal Cowdung + lime	3 + 100 10	...	20	$25\frac{5}{8}$
	(*c*)	Ditto(*b*) + lime	30	...	$17\frac{3}{4}$	$26\frac{1}{2}$
	(*d*)	Ditto(*b*) + lime	60	...	$15\frac{3}{8}$	$24\frac{7}{8}$
3	(*a*)	Bonemeal	3	...	$19\frac{5}{8}$	$26\frac{1}{8}$
	(*b*)	Bonemeal Lime	3 10	...	$18\frac{1}{3}$	$25\frac{3}{4}$
	(*c*)	Do.(*b*) + lime	30	...	$19\frac{3}{8}$	24
	(*d*)	Do.(*b*) + lime	60	...	$15\frac{1}{2}$	$24\frac{3}{8}$
4	(*a*)	Unmanured		...	$17\frac{7}{8}$	$25\frac{1}{2}$
	(*b*)	Lime	10	...	27	$25\frac{2}{8}$
	(*c*)	Do.	30	...	$16\frac{7}{8}$	$24\frac{7}{8}$
	(*d*)	Do.	30	...	12	$27\frac{1}{2}$

A study of these figures reveals the fact that we are dealing with ununiformity. With an outturn of 25½ mds. of *aus* paddy from an unmanured plot there is no need to apply any manure till more definite differences are obtained.

	Mustard after *aus* (yield per acre) in maunds.			Mustard after green manure in maund (y. p. a.)	
		Duplicate.			Duplicate.
1.	(*a*) Cowdung, 100 mds.	2¾	1⅞	(*a*) 2¼	1¼
	(*b*) Ditto, lime 10 „	4⅞	3⅕	(*b*) 4	3¾
	(*c*) Ditto, „ 30 „	6¾	4½	(*c*) 4⅜	7⅞
	(*d*) Ditto, „ 60 „	8	6¼	(*a*) 5½	5¾
2.	(*a*) Bonemeal 3 mds to *aus*, cowdung, 100 mds. to mustard ...	3⅞	2⅝	(*a*) 3⅝	2⅞
	(*b*) Bonemeal, cowdung, lime, 10 mds.	6¼	6	(*b*) 5	6
	(*c*) Bonemeal, cowdung, lime, 30 „	7⅞	7¼	(*c*) 7¼	8
	(*d*) Bonemeal, cowdung, lime, 60 „	8	8	(*d*) 7	8¼
3.	(*a*) Bonemeal, 3 „	2⅛	2	(*a*) 1¼	2¾
	(*b*) Ditto, lime, 10 „	3⅜	7⅛	(*b*) 5⅛	4⅞
	(*c*) Ditto, „ 30 „	5	6½	(*c*) 6⅝	6⅞
	(*d*) Ditto, „ 60 „	5¾	7¾	(*d*) 7⅝	7¼
4.	(*a*) Unmanured ...	1/6	¼	(*a*) ¼	¼
	(*b*) Lime 10 „	⅛	2¼	(*b*) 1/10	⅝
	(*c*) Do. 30 „	¾	7	(*c*) ½	2¼
	(*d*) Do. 60 „	⅞	5⅞	(*d*) 2	3

The striking features about these figures are first that mustard after green manure loses the *aus* paddy crop; second that a *rabi* crop after *aus* is just as good as *rabi* after green manure; third that even when green manure and lime have been applied the *rabi* crop is economically very bad.

Conclusion.—Take an *aus* crop no matter what else is attempted It seems fairly evident from the above *data* that the highland of this farm and tract is not suited to *rabi* crops under present conditions.

These experiments will be continued.

Low land experiments—

Aman paddy (*a*) Variety.
(*b*) Manurial.
(*c*) Planting and spacing.

(*a*) *Variety experiment.*—This is in the hands of Mr. Hector the Economic Boatanist, who is not yet prepared to make any definite recommendations. He hopes, however, to obtain something conclusive this year.

(*b*) *Manurial experiment on winter paddy.*—This experiment was commenced in 1908. Manures were applied in 1908 and 1909 after which they were discontinued and the residual effects are now being observed.

The following tables gives the manurial applications with the average outturns for 1908 and 1909 with the actual outturns for 1910 and 1911 :—

Per acre—Average of duplicate plots.

Manures applied, 1908-1909.	Average of 1908-09.		1910, without Manure.		1911, without Manure.	
	Yield.		Yield.		Yield.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	Mds. S.	Mds. S.	Mds. S.	Mds. S	Mds.	Mds.
Green-manured (dhaincha)	24 1	32 5	19 6	12 30	22	50
Ditto (Sunnhemp)	14 5	17 21	14 23	10 16	19	34
Unmanured ...	17 7	25 31	22 0	13 37	19½	47
Bonemeal 3 manuds ...	24 6	44 29	25 1	18 22	25¾	62⅛
Ditto 3 manuds and salpetre 30 seers.	23 19	40 21	22 22	18 37	23⅛	62¾
Bonemeal 3 maunds and ammonium sulphate.	22 23	41 7	25 36	20 6	20¾	45¾
Bonemeal 3 maunds and calcium nitrate.	26 23	38 1	26 2	21 37	24¼	54
Bonemeal 3 maunds and cotton seed.	23 37	39 11	25 12	22 22	23¼	56¼
Fish manure ...	32 15	35 6	21 10	22 12	18⅓	37¼

From the figures both bonemeal and *dhaincha* seem still to be affecting the yield per acre. Bonemeal has the greatest residual effect while fish manure which gave the highest return in the years of application seems to have no subsequent effect.

(*c*) *Planting and spacing experiment.*—This has been carried out for three years. One, two, three and four seedlings in a bunch are transplanted at distances apart of 8″, 10″ and 12″. The yield per acre figures show that the difference due to want of uniformity in the plots is greater than the number of seedlings and the distance apart in transplantation, so no figures are published.

(*c*) *Conservation of cattledung.*—The farm cowdung is collected and stored in pits but the effect of storing in covered pits has not been compared with the local method of allowing the manure to be exposed to the weather.

This will be taken up.

(*d*) *Distribution of seed.*—This farm acts as a centre for the seed supply of this part of the province. During the year the following seeds, manures and implements were distributed :—

Aus paddy	76⅝	Mds.
Winter paddy	29¼	„
Sugarcane cutting	50,000	
Paddy seedlings from ...	15	Mds.
Potatoes	430	„
Sunn hemp ...	25	„
Bonemeal	221	„ besides a small quantity of other seeds.
Dhaincha seed	40	Mds. Ditto.
Meston ploughs	4	
Planet Junior Hoes	3	
Maize Huler	1	

(*e*) *Practical Training of young men.*—During the year 11 men received practical training at this farm. After a course of two years on this farm certificates are granted to those persons who give satisfaction in their work. Of the 11 men 3 were post-graduate students from Poona College and of these one has been appointed District Agricultural Officer, Mymensingh, one has been transferred to Jorhat for further training, while one is ready for an appointment. The remaining eight persons are apprentices for departmental demonstration work. Four of these completed their training during the year and have been drafted out in the Province.

8. *Receipts and expenditure.*—During the year ending June 30th 1912, the following receipts for this farm were paid into the treasury, Rs. 7,235-7-9, while Rs. 29,654-6-5 were incurred as expenditure.

Details of expenditure—	Rs.	A.	P.
Farm establishment	2,168	10	11
Permanent improvements	8,102	8	9
Labour	9,940	0	3
Cattle food	2,210	12	9
Implements	1,085	5	9
Seeds and manures	1,427	14	6
Repairs	2,336	2	6
Country implements and repairs ...	622	0	3
Miscellaneous	1,760	14	9
	29,654	6	5

The permanent improvements, cattle food, implements repairs and miscellaneous expenses are far too heavy and should be curtailed. The Superintendent can also easily economise on the labour bill.

9. *Acknowledgments.*—I am indebted to Mr. A Meggitt, Agricultural Chemist, for the soil analysis, to Mr. R. S. Finlow, for the rainfall figures at the Dacca Farm in 1911-12 and to Mr. J. H. Field, officiating Director General of Observatories, for the normal rainfall and number of rainy days during the past ten years. I take this opportunity of recording my hearty thanks for the help received.

10. *Management.*—The farm is managed by the Agricultural Department. Babu Kali Das Roy was the Superintendent in charge during the year. Mr. Birt was the Deputy Director of Agriculture up to March 31st 1912, when his work was taken over by Mr. Smith. Mr. Hart was the Director of Agriculture up to May 1912 when Mr. Blackwood took over charge. The farm has been constantly inspected by all the above superior officers.

11. *Appendices.*—

First map of farm.
Second plan of highland experiments.
Third Mr. Meggitt's report.

F. Smith,

Deputy Director of Agriculture, Bengal.

APPENDIX III.

Note on North Hazi Soil Improvement Experiment.

Results of first year's work.

This experiment, laid down early in 1911, comprising four blocks of upland soil of one acre each, thus allowing of duplication, and referred to in a report on the high land soil of the Dacca Farm printed as an appendix to the Dacca Farm Report for the year ending 30th June 1911, has yielded very marked and interesting results during the past year.

Briefly the experiment—essentially a soil improvement scheme and not merely a study of the particular manurial requirements of one or two crops only—is an attempt to study the lime requirements of these old alluvial red acid soils, with and without green manuring, and again with and without the addition of phosphoric acid in the form of bonemeal, with special reference to cold weather crop production, at present almost an impossibility.

The application of nitrogen in the form of cow-manure is included and considered in combination with the above. A scheme of manuring to cover six years has been laid down, and a suitable rotation of different crops, which are to serve as indicators of the extent of the soil improvement effected, has been arranged.

Bearing in mind then the scope and intentions of the scheme, and the varying requirements of different crops together with the unevenness of the soil, it will be quite obvious that the indications of only one year and covering only two crops, cannot be insisted on very strongly.

Results to date are, however, so striking in some instances and so consistent, despite some soil variations within the experimental area, that their mention is perhaps permissible and moreover one is confirmed in the belief and hope that information of very great and economical value as to the treatment of the similar soils under similar climatic conditions will be forthcoming as the scheme works itself out.

It may further be remarked that field experiments of this sort, extending over a long period and covering different cropping, furnishes an opportunity for important laboratory studies, and this aspect of the work is being taken up as time and opportunity permit. Such problems include the influence of varying applications upon the chemical, physical, and bacteriological properties of these soils, covering determinations of acidity, soil moisture during the dry months, also removals of plant foods by different crops, the effect of manuring on crop composition, and on the physical constants of the soil, etc., etc.

It is significant that such fundamental knowledge as we now possess is largely the result of laboratory studies. What we know of the essential constituents of plants, the supply of plant foods in the soil, losses from soil under varying conditions, the influence of soil texture on water-supply, and

other important facts and principles, has come almost entirely from chemical and bacteriological studies. The results of field experiments are end results that are influenced by a number of factors such as soil composition and texture, water-supply, soil flora, and climatic conditions, a situation so complex that it is practically impossible to assign to any one factor its relative influence upon crop production in any particular field experiment.

Field experiments show that in a certain locality with a given soil, different methods of treatment give different results in crop production, but as a rule these results are not self-explanatory and they may or may not serve as a guide to practice in some other locality.

Conditions are so variable that as a rule a system of soil treatment must usually be developed on the basis of general principles, rather than by slavishly imitating practice that is successful in some other locality.

It is part of our duty as scientific agriculturists to search out these fundamental principles, and the process must be slow and expensive if the conclusions are to be sound.

The manuring of soil such as we are working on, and under the climatic and cropping conditions obtaining, is we are convinced in many respects a far different problem from that which obtains in many other tracts of India, and will bear and pay for much patient investigation.

We may now consider briefly the results to date.

The rains crops were (*a*) *dhaincha* for green-manure on two diagonally opposite plots of one acre each; (*b*) *aus* paddy on two other diagonal plots of the same area. The *rabi* cropping was mustard on all four blocks.

Field observations during growth.—Kharif cropping.—The general effect of the differential manuring was much more apparent in the case of *dhaincha* than on the *aus* crop. The effect of the varying applications of lime on *dhaincha* was very marked indeed, progressively with increasing quantities up to 60 maunds per acre. With greater growth above ground went hand in hand greatly improved root development, a desideratum in opening up and ærating an unkind sub-soil.

The action of lime on the *aus* paddy, on the other hand, was not nearly so apparent.

The dressing of bonemeal, confirming the beneficient results so widely obtained by us with this manure, also exercised everywhere a most pronounced effect on *dhaincha*, not quite so striking in the case of the *aus* crop though very well marked here also.

The following are the actual figures showing the effect of the bonemeal on the *aus* crop:—

Average yield per acre from four non-manured plots—Mds. 19-36 grain.

Average yield per acre from four plots manured with three maunds bonemeal per acre—Mds. 24-12 grain.

The grain sold at Rs. 2 per maund, so that the extra grain just paid for the manure used, and this on one crop only.

One must also bear in mind the residual effect of the bonemeal, which as will be seen later returned a handsome profit in the case of the succeeding mustard crop, making no further application of manure of course.

The conclusion may be drawn that for *dhaincha* as a green crop on these acid red soils, the use of at least 10 maunds of lime, *plus* a small dressing of bone-meal is highly advantageous in accelerating and improving the growth of this crop, but that while the beneficial effect of bones was well shown on *aus* paddy, the avantage to be derived from using lime in addition is by no means indicated to date. Indeed, the heavier dressings of lime most certainly appeared to have had an adverse influence on this crop during the first year after application. Probably the limiting factor on these soils for paddy is phosphoric acid; for other crops it is also of great importance, but its effects are in their case increased with the addition of lime.

Rabi *crop* —*Mustard.*—It is, we believe, on the cold weather cropping that the scheme of manuring will exercise its greatest effects.

On the old alluvial red soils, of which this is a type, cold weather cropping is little attempted, because in the absence of special treatment it is well nigh impossible to get a crop which will pay for itself.

The soil dries out badly in the *rabi* season, and assumes such a physical character as to render its cultivation with native implements very difficult indeed in many cases, unless it be caught in the nick of time.

Poor starved extremely thin crops of mustard and *mati kalai* may be seen here and there on this class of land, but they can hardly pay even for the harvesting in many cases.

Our expectations were fully realised, the outturn of grain varying from a few seers per acre from the non-manure plots, and ranging up to over eight maunds per acre on the manured plots, and in many cases returning a handsome profit on extra outlay, charging the whole of the manuring to the one mustard crop.

Field observations during growth of the mustard crop.—First, comparing the crops as a whole on the blocks which had been green-manured during the rains with those on the non-green-manured areas, it was early quite clear that the green-manured areas were somewhat under a cloud; they were evidently suffering more or less in different parts, by comparison with the other areas, from a lack of moisture. This state of things was quite the opposite of what might be expected as a result of the incorporation of organic matter, but is quite easily comprehensible in this instance. The green-manured crop of *dhaincha*, owing to stress of weather which made the land quite unworkable for a time, could not be ploughed in until quite late in August, and by that time the *dhaincha* had become very strong and woody in the stem.

The danger of this happening with *dhaincha* is not great in normal years but this was an abnormal one as regards rainfall. It is a contingency that we fully realise, and it may be that in view of the fuller knowledge of other green manure crops which we now have, some other green crops which is not so liable to get out of hand may be introduced into the scheme later in place of *dhaincha*.

Though good rains fell after its corporation with the soil, still the woody sticks did not decay; they persisted in the soil, opening it up to such an extent as to defeat one of the chief objects of green manuring, viz., the increase in the water holding capacity of the soil by the increase of the amount of humus.

Moreover, the soil became so dry as to make it quite improbable that any large amount of the nitrogen and other fertilising ingredients of the *dhaincha* was rendered available for the immediate crop of mustard (that this is largely true is clearly seen on these plots in the very much greater luxuriance of growth of the succeeding *aus* crop, over that of the same crop on the non-green manured areas).

In the result, the actual outturn bore out the field observations, the average yields per acre of grain being as follows :—

	Mds. s.	
Green-manured blocks ...	4 20	(average of 2 duplicate 1 acre plots.)
Non-green manured blocks	4 4	ditto ditto.

the difference being just within the permissible experimental error of 10 per cent. Other aspects of this matter will be mentioned later.

In regard to the other manurial treatments, the application of cowdung to certain plots showed a very early and very marked beneficial effect which persisted throughout.

The positive action of bonemeal though not so distinct in the early stages became very evident later on.

Lime, where used alone, was very effective, its action appearing to increase with increasing applications ; also where used in increasing amounts in conjunction with other manures, *e.g.*, bonemeal alone, or bonemeal and cowdung together, or cowdung alone, the result was apparently in all cases progressively better crops.

The above observations were fully confirmed by the results, which will be readily gathered from the subjoined table, the figures representing the average yield per acre of duplicate plots each receiving the same treatment :—

	GRAIN.							
	Green manured blocks.				Non-green manured blocks.			
	0 lime.	10 maunds lime per acre.	30 maunds lime per acre.	60 maunds lime per acre.	0 lime.	10 maunds lime per acre.	30 maunds lime per acre.	60 maunds lime per acre.
	Mds. s. c.	Mds. s. c.	Mds. s. c.	Mds. s. c.	Mds. s. c.	Mds. s. c.	Mds. s. c.	Mds. s. c.
Cowdung 100 maunds per acre applied before *rabi* crop.	1 32 0	3 24 8	4 24 8	52 6 8	2 13 0	4 5 0	5 25 8	7 7 0
Bonemeal 3 maunds, cowdung 100 maunds.	3 10 8	5 24 8	7 21 0	7 28 0	3 10 8	6 4 0	7 24 8	8 4 0
Bonemeal 3 maunds per acre.	2 2 8	5 0 8	6 31 0	7 7 8	2 10 0	4 1 0	5 28 0	6 30 8
Nil	0 3 0	0 15 0	1 17 8	2 24 0	0 9 0	1 10 0	3 35 0	3 15 0

Analysing these figures and considering the blocks as a whole, it will be seen I think that they bear out the supposition that the slight immediate adverse

effect of the green manuring was due to the woody stalks of *dhaincha* opening up the soil and thus helping to dry it out somewhat. If this be true then the greater diminution of outturn should occur where the *dhaincha* was biggest and most woody and this was on the areas which received 30 and 60 maunds lime right through, plus the varying cross dressings.

From the figures it may be calculated that the reduction in crop due to green manuring against non-green manuring was as follows :—

For the 30 and 60 maunds lime strips 10 per cent. reduction.
For the 0 and 10 „ „ „ 7·4 „ „

Further study of these figures discovers a most interesting point relating to the use and value of phosphates on this soil. It is this, that considering only that part of the area in either block which received bonemeal, the total yield of grain from the green-manured block exceeds that from the non-green manured block, despite the fact that this area must have suffered from lack of moisture in common with the rest of the plot. The explanation suggests itself that, on the green-manured block, one action of the added green matter was to accelerate the solution of the insoluble phosphate added, and that the extra amount of available phosphate the crop received in this manner, more than counterbalanced the probably slightly less amount of moisture in the soil.

This small extra supply of available phospheric acid might conceivably act beneficially to produce the above result, probably in two ways, viz., by improving the bacteriological condition and by enabling the crop to produce its dry matter at a less expense of water transpired per unit, of dry matter manufactured, by virtue of presenting to the plants' roots a slightly more concentrated solution This is strictly in accordance with well known principles.

Considering the results generally of the mustard crop, and neglecting the slight temporary adverse effect noted due to green-manuring, taking the average yields per acre from the plots receiving otherwise similar treatment on the whole of the four one-acre blocks, and for convenience reckoning the whole of the cost of the several manurial treatments against the single mustard crop, some most valuable results emerge.

The large amount of evidence which we have accumulated as to the very great value of bones as a supplier of phosphoric acid on these red alluvial soils is abundantly confirmed, and amplified to include now cold weather cropping.

The use of bone meal alone returned a net profit of over Rs. 2 per acre on the single crop, and charging the whole cost of the manure (Rs. 9) to it.

The results show however that, though it increases the outlay somewhat, it is a combination of bones and lime which appears to be pre-eminently required, Our results confirm the ability of lime to increase the efficiency of phosphates.

The plots receiving 10 maunds lime and 3 maunds bonemeal, costing Rs. 15-4 per acre, gave a very much larger crop and the net profit was increased to Rs. 9 per acre, and this in spite of the fact that a dressing of 10 maunds lime alone returned a small loss on the crop.

With increasing doses of lime, keeping the bonemeal at 3 maunds per acre the outlay is of course considerably increased, and nothing but losses could be

expected in one year where very large amounts are applied. Nevertheless the plots which had 30 maunds lime and 3 maunds bonemeal, costing Rs. 27-12 per acre, returned a net profit of nearly Rs. 6 per acre, on the single crop of mustard. Where 60 maunds per acre of lime, together with bonemeal was used, the loss per acre was less than that returned by it with any other combination of manures. It is necessary to explain here that those areas which received large quantities of lime, will not be given any further addition during the course of scheme, so that it is hoped that the losses incurred on the first year's working will gradually become with time into profits.

The results also indicate that 30 maunds lime is the greatest amount that should be used at any rate in one application. Increasing it to 60 maunds increased the outturn but little, but augmented the loss considerably, on the single crop.

In all cases, the outturn was increased by the addition of cowdung to the varying lime and bone dressings, but at increased outlay and showing somewhat reduced profit, or increased loss, as the case may be.

Cowdung alone 100 maunds per acre (and costing about the same as 3 maunds bonemeal, viz., Rs. 9-6) gave a small profit of Re. 1-4 per acre, which was increased to Rs. 5 per acre when used along with 10 maunds lime. With 30 maunds lime it returned a slight loss, and a much bigger one with 60 maunds lime.

The combination of lime, bones and cowdung gave the highest outturns in all series, increasing with increasing lime applications. It was however from 10 maunds lime and 3 maunds bonemeal that the greatest profit accrued, the manuring costing Rs. 15-4 per acre. This is admittedly more than most cultivators can afford, but we have good reason to believe that the same end may be achieved at a less outlay than the above, and work is being instituted with this end in view. Manuring, to be practicable in India, must be cheap, and this point of view is being steadily kept in mind.

If one may be permitted to draw any conclusions so early they would be as follows :—

1. The limiting factor on these soils for paddy appears to be phosphoric acid, and bonemeal is an excellent manure to use for its supply.

2. For green manure crops generally, though they also benefit much from an application of phosphate, the use of a little lime is also to be recommended.

3 *Dhaincha* is an excellent green crop to grow, but it must be ploughed in to the land before it gets woody and early enough (by middle of July in any case) to enable subsequent rain to thoroughly decompose it, before the *rabi* crop is sown.

Where the land is very heavy and impossible to work, when at all wet, then the substitution of some other more herbaceous green crop, such as *mati kalai* or cowpeas, would appear to be desirable.

If the *aus* paddy crop can be sown early and got off in good time, work now in hand indicates that cowpeas may be taken as a catch green manure crop before making the *rabi* sowings. This is of vital importance from the raiyat's point of

view, as it seems quite certain that green manuring can never become at all general unless this can be done.

4. For *rabi* cropping, though phosphate application appears again to be of enormous value on these soils, the use of an initial small dressing of lime in addition is clearly indicated.

5. Though cow-manure is of course useful at all times still under such conditions as ours and with *aus* paddy as the rains crop, it is probably more economical to apply it to the cold weather cropping, and every ounce a cultivator can accumulate ought to be carefully conserved and used.

My former colleague, Mr. Birt, co-responsible with me for this work and to whom is due the greater portion of any credit for the inception and working of this scheme for the period under review, approves of this note and we wish to record our appreciation of the amount of interest and care which has been given to it by the Farm Superintendent and his staff.

A. A. Meggitt,

Agricultural Chemist to the Government of Bengal.

The 5th September 1912.

B. S. Press—21-2-1913—2344J—800—C. A. P.

GOVT. FARM.
DACCA

YIELDS PER PLOT $\frac{1}{160}$th ACRE EACH.

NORTH HAZI EXPERIMENTAL PLOTS. 1911–12.

Kharif crop in black print, Rabi crop in red.

	1	2	3	4
Cowdung 100 mds. per acre applied before Sowing Rabi Crop. — d	Aus 1-7-3 18 7/8 Mustard 0-7-0 — 2 3/4	Aus 1-1-10 — 16 5/8 Mustard 0-12-2 — 4 7/8	Aus 1-2-10 — 17 Mustard 0-16-15 — 6 3/4	Aus 2-23-12 — 41 1/2 Mustard 0-20-4 — 8
Bonemeal 3 mds. per acre. applied before Sowing Kharif Crop and Cowdung 100 mds. per acre applied before Sowing Rabi Crop. — c	Aus 1-14-5 — 21 3/4 Mustard 0-9-11 — 3 7/8	Aus 1-11-1 — 20 3/5 Mustard 0-15-9 — 6 1/4	Aus 1-4-9 — 17 3/4 Mustard 0-19-13 — 7 7/8	Aus 0-37-14 — 15 3/8 Mustard 0-20-4 — 8
Bonemeal, 3 mds. per acre — b	Aus 1-9-4 — 19 5/8 Mustard 0-5-6 — 2 1/8	Aus 1-6-5 — 18 1/2 Mustard 0-8-8 — 3 3/8	Aus 1-8-6 — 19 3/8 Mustard 0-12-6 — 5	Aus 0-38-11 — 15 1/2 Mustard 0-14-5 — 5 3/4
Nil — a	Aus 0-32-4 — 12 7/8 Mustard 0-0-7 — 7 Seers	Aus 1-28-10 — 27 1/2 Mustard 0-0-8 — 8 Seers	Aus 1-2-5 — 16 7/8 Mustard 0-2-0 — 3/4 md	Aus 0-32-7 — 12 Mustard 0-2-3 — 7/8 md

C

	1	2	3	4
d	Mustard 0-5-12 — 2 1/4	Mustard 0-10-1 — 4	Mustard 0-10-15 — 4 3/8	Mustard 0-13-12 — 5 1/2
c	Mustard 0-9-2 — 3 5/8	Mustard 0-12-14 — 5 3/5	Mustard 0-18-1 — 7 1/4	Mustard 0-17-12 — 7
b	Mustard 0-3-5 — 1 1/4	Mustard 0-13-0 — 5 1/8	Mustard 0-16-10 — 6 5/8	Mustard 0-17-10 — 7 1/2
a	Mustard 0-0-3 — 3 Seers	Mustard 0-0-4 — 4 Seers	Mustard 0-1-5 — 1/2 md	Mustard 0-5-4 — 2 mds

D

1912
A B C & D under Aus.

	1	2	3	4
Cowdung 100 mds. per acre — d	Aus 1-17-0 — 22 3/4 Mustard 0-3-4 — 1 1/4	Aus 1-18-1 — 23 3/4 Mustard 0-8-0 — 3 1/4	Aus 1-18-14 — 24 Mustard 0-12-2 — 4 7/8	Aus 1-19-4 — 24 1/8 Mustard 0-14-9 — 5 3/4
Bonemeal 3 mds. per acre and Cowdung, 100 mds. per acre — c	Aus 1-32-14 — 29 1/8 Mustard 0-7-3 — 2 7/8	Aus 1-24-0 — 25 5/8 Mustard 0-15-3 — 6	Aus 1-26-6 — 26 1/2 Mustard 0-20-1 — 8	Aus 1-22-3 — 24 7/8 Mustard 0-20-12 — 8 1/4
Bonemeal 3 mds. per acre — b	Aus 1-26-6 — 26 1/2 Mustard 0-6-14 — 2 3/4	Aus 1-24-4 — 25 3/4 Mustard 0-12-1 — 4 7/8	Aus 1-20-4 — 24 Mustard 0-17-4 — 6 7/8	Aus 1-21-0 — 24 3/8 Mustard 0-18-5 — 7 1/4
Nil — a	Aus 1-23-13 — 25 1/2 Mustard 0-0-11 — 11 Seers	Aus 1-24-3 — 25 5/8 Mustard 0-5-12 — 2 1/4	Aus 1-22-2 — 20 7/8 Mustard 0-17-6 — 7	Aus 1-28-14 — 27 1/2 Mustard 0-14-11 — 5 7/8

A

B

1	2	3	4
Nil	Lime, 10 mds. per acre	Lime, 30 mds. per acre	Lime, 60 mds. per acre

BLOCKS A. & D. HAD A CROP OF DHAINCHA FOR GREEN MANURE PLOUGHED IN DURING THE RAINS OF 1911
THE 2nd. FIGURE IN EACH CASE IS THE OUTTURN PER ACRE IN MAUNDS.

SITE PLAN OF CENTRAL FARM
AT
MANIPUR, DACCA

SCALE 300' = 1"

N

OFFICE FIELD. W.
OFFICE FIELD. E.
PADDOCK.
MANGO GARDEN
OFFICE BYE
FARM BUILDINGS
OVERSEER QR.
SUNTIS TANK
SUPERVISOR
SEPTIC TANK
AGIRGAON
ROAD FROM FARM TO MIRPUR
MANGO GARDEN
MIRPUR. N.
HAZI. N.
SUNTI.
MASTUL
HAZIS TANK
MIRPUR. CENTRAL
RAKHALI BYE
HAZI. S.
SHOTI. W
MANGO GARDEN
SHOTI. E.
KHOSH KHANA RAVINE
MANGO GROVE (POULTRY)
EAST RAVINE
SUTITANK
MIRPUR. S.
TO MIRPUR ROAD
ASSISTANT AND CLERKS QR
PLAY GROUND
MANIPUR VILLAGE
MIRAR TAK. N.
DAR BARI RAVINE
MUSTAR TAK. N.
BRICKFIELD RAVINE
MANIPUR RAVINE
ZALLA BISRA RAVINE
MIRAR TAK
MUSTAR TAK
SOUTH RAVINE
WELL
FARM HOUSE
PISCICULTURE
PETROL SHED
POWER HOUSE
LABORATORY
MAIN ROAD
Kitchen Garden
POULTRY.
BOTANIC GARDEN
ROAD TO DACCA